# FELDSPATHIC CUMULATE SAMPLES AND PLUTONIC ROCKS IN GALE CRATER: COMPARISONS TO MARTIAN METEORITES.

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**Introduction:** The Curiosity Rover of Mars Science Laboratory has identified igneous float rocks in Gale Crater which offer new insights about the differentiation of the martian lithosphere. Here we describe likely origins for some unique Gale plutonic and cumulate rocks and compare to the martian meteorites. At the Ireson Hill locality around sol 1606 a group of float rocks with resistant, dreikanter morphologies were identified which include igneous textures, notably the 10 cm Pogy sample. On sol 2016 of the MSL mission, a group of float rocks were studied in detail, including Askival, which is a light toned rock igneous rock similar to Peacock_Hills (sol 19) and Bindi (sol 544).

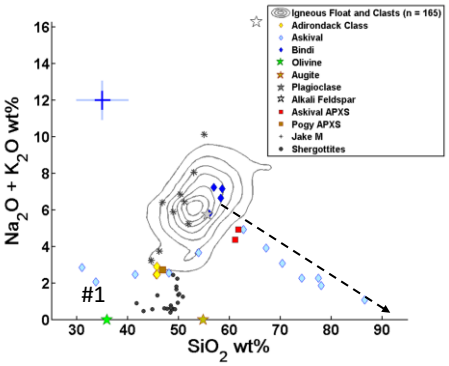


Figure 1. Gale igneous and shergottite compositions. Dashed line shows silicification (with hydration) of Askival feldspathic cumulate. #1 is Askival LIBS is ferrohastingsite (with Fe oxide and sulfate). Jake_M [5], trachybasalt density contours [6].

**Methods:** ChemCam contains a NIR laser and telescope within MSL's mast and 3 spectrometers inside the body unit [1,2]. It remotely analyses targets by Laser Induced Breakdown Spectroscopy, with optimal performance at ≤4 m, and also has a Remote MicroImager. Typically, there are around 30-50 laser shots on a single observation point in a raster (e.g. two 10 x 1 rasters and one 3 x 1 raster on Askival). A combination of ICA and PLS are used to derive major oxide compositions [3]. $H_2O$ is determined with a univariate method [4]. The Alpha Particle X-ray Spectrometer (APXS) provided 3 analyses on Askival [5]. This float rock was first identified during MSL operations using MastCam and MAHLI images.

**Results:** *Gale Feldspathic Cunulates.* Askival is a 10 cm long, partially buried, float rock. It contains light-toned subhedral mineral grains (up to ±10 mm long) as well as dark and grey-toned minerals and veins. The light-toned grains (phenocrysts) comprise 65/70 % of the rock, and are in places poikilitically enclosed by the dark-toned assemblage which comprises 30/35 % of the rock. Bindi has a cumulate texture defined by ~80% tabular feldspar grains. *Pogy and Related Samples at Ireson Hill Locality.* MAHLI images reveal that Pogy has a 1.5 mm equigranular, plutonic texture, which has not been identified before at Gale. A series of 4 other float rocks at this locality may be related. *Mineral Compositions.* All but one of the LIBS spots on Askival show non stoichiometric compositions. Figure 1 shows that the light toned Askival compositions are a mixture of a relict intermediate plagioclase phase with $SiO_2$ in a 70:30 ratio. Silica-rich point analyses range up to >80 wt%. Point Askival#1 has $SiO_2$ 34 wt%, $Al_2O_3$ 6.8 wt%, FeO 28.4 wt% CaO 14.4 wt% and $Na_2O + K_2O$ 2.1 wt% implying that it escaped the silica overprint. LIBS shot analyses indicate that this is a mixture of iron oxide, sulfate and ferrohastingsite. In Askival #1 fluorine is also detected. Pogy has a basaltic composition with $SiO_2$ (APXS) 42 wt% with $Na_2O + K_2O$ 2.5 wt%, MgO 7.8 wt%. *Hydration of Light Toned Phases.* LIBS of Askival suggest an equivalent $H_2O$ content in the relict feldspar grains of ~9-13 wt% $H_2O$.

**Discussion:** Our compositional and textural data suggest that Askival was originally a plagioclase-mafic cumulate that has been silicified and hydrated. The other Gale feldspathic cumulate samples analysed e.g. Bindi did not experience this alteration.. These feldspathic cumulates are unique in the inventory of landing site igneous samples and martian meteorites. The cumulate melt is likely to be related to the trachybasalt/trachyandesites [6,7]. This in turn was formed through fractional crystallisation of an Adirondack-type melt [6]. In contrast, the Pogy textures and composition suggest a basaltic (Adirondack) plutonic origin. Gale Crater has preserved a record of igneous differentiation and plutonic activity with higher alkali contents than that recorded by the shergottites .

**References:** [1] Wiens R.C. et al. (2012) *Space Sci. Rev*. 170 [2] Maurice et al. (2012) *Space Sci. Rev*. 170 [3] Clegg S.M. et al. (2017) *Spectrochimica Acta Part B*: *Atomic Spectroscopy* 129. [4] Rapin W. et al. (2017) *Spectrochimica Acta Part B*: *Atomic Spectroscopy* 130. [5] Schmidt M.E. et al. (2014) *JGR*, 119. [6] Edwards et al. (2017) *MAPS* 52 [7] Cousin A. et al. (2017) *Icarus*, 288.